

## COCONUT LEAF WASTE PROCESSING WITH BIODRYING PROCESS AS RAW MATERIAL FOR BIOMASS PELLETS IN WASTE TO ENERGY

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### ABSTRACT

Coconut leaf waste is a type of waste that contains a good enough calorific value to be used as raw material for biomass pellets. The minimum standard calorific value of biomass in Indonesia according to SNI 8675:2018 is 16.05 MJ/kg. Meanwhile, based on the research results, the calorific value of coconut leaf waste has a value of 13.34 MJ/kg. The way that can be applied to increase the calorific value is by biodrying. This study aimed to determine the effectiveness of the biodrying process in processing coconut leaf waste. This study use bioactivators in the form of tempe yeast, baker's yeast, and tapai yeast. Mass loss and moisture reduction can be achieved, respectively, 8.25 - 17.62% and 62.4-65.6%. The calorific value can reach the minimum standard after seven days of processing with a value of 17,995-18,623 MJ/kg.

**Key word:** biodrying; coconut leaves; waste; caloric value.

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### INTRODUCTION

The Bali Island is known as the Island of a Thousand Temples. Prayers are carried out every day by residents using various means. Some of the leading facilities in the procession of Hindu worship in Bali. Coconut leaves used as the main ingredients for making canang, and sampian in fresh coconut leaves from the coconut plant (*Cocos nucifera* L.) obtained from Bali and outside Bali or coconut leaves from the coconut plant. The rest of this can produce waste, and research also shows that this waste generation made from coconut leaves is found in water bodies (Widyarsana et al., 2020). The problem of waste in water bodies is indeed a significant problem in Bali Province, especially related to marine debris (Septiariva & Suryawan, 2021).

Waste can be appropriately managed through increasing public awareness of the environment and collaboration with various stakeholders to take advantage of opportunities for renewable energy sources through the development of technology for converting waste into energy. The waste management system has progressed and can even be used as alternative energy in waste energy generation but has not been used optimally on a large scale. Various waste utilization techniques can be applied to convert waste into energy, namely, thermal conversion technology and biological mechanisms. Waste energy conversion in the form of thermal with a pyrolysis system has been carried out in several areas in Indonesia, including the Province of Bali (Qonitan et al., 2021). However, this process requires quality fuel with low moisture content and high calorific value.

Coconut leaf waste tends to have reasonably high water content and has a high calorific value potential, so proper processing is needed to remove the water content (Pestaño & Jose, 2016). One of the processing that can be done is the biodrying process (Suryawan et al., 2021). The biodrying process takes a long time, so that in its application, a biocatalyst is needed to remove water. The biological catalysts that can be used are fungi. Some of the fungi that can be found in the Indonesian market are tempe yeast, baker's yeast, and tepai yeast. This study aimed to determine the effectiveness of processing coconut leaf waste with the addition of yeast bio activator on coconut leaf waste to obtain the optimum calorific value.

## RESEARCH METHODS

### Materials

The volume reactor that used in this study is 2 litres in size, where the reactor used is closed. The air supply is carried out using an aerator with a flow rate of  $\pm 2$  L/min each. The reactor is equipped with a sampling port to analyze the humidity and pH of the waste every day. At the bottom, it is fitted with a bulkhead containing perforated baffles to collect leachate (Figure 1). Moisture and pH measurements were carried out with a moisture meter and a pH meter. The coconut leaf waste used is fresh waste produced at that time. The mass of the waste is measured using a digital scale. Before weighing the leachate chamber, it is ensured that there is no water remaining. The waste mass is the measurement when considered minus the mass of the reactor.

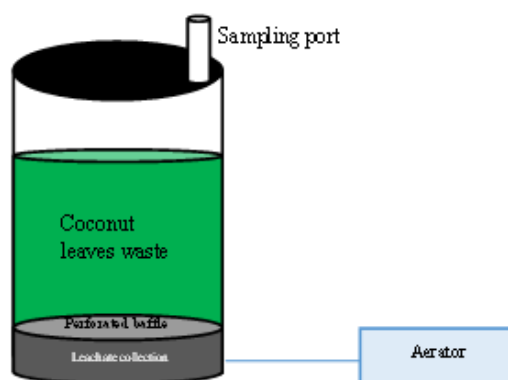


Figure 1. Biodrying Reactor used in Coconut Leaf Waste Treatment

### Methods

This research was conducted in the Bekasi area, West Java, in October – November 2020. Samples of coconut leaves were obtained from nearby markets. The calorific value test was carried out in the laboratory of the Animal Research Institute (Balitnak), Bogor, West Java. Moisture measurement is carried out with a moisture meter adjusted. Meanwhile, pH measurement is also carried out with a pH meter that is adjusted. The measurement of pH and moisture is carried out every day, including temperature. Temperature is measured with a thermometer. Calorific value measurements were carried out at the beginning and end of the study. Measurement of calorific value using bomb calorimetry with standard SNI 01-6325-2000. The detention time used in this study was seven days and an increase in the airflow rate of 2L/minute based on previous research by (Fadlilah & Yudihanto, 2013).

### Data Analysis

Data analysis was carried out by descriptive method on changes in moisture value, water content, temperature and pH. The calorific value results are compared with the criteria set in Indonesia. In addition, data analysis is also supported by literature studies related to this research.

## RESULT AND DISCUSSION

The results of the measurement of the initial characteristics of coconut leaf waste can be seen in Table 1. The measurement results show the moisture content value of 31.4-36.1%, while the known calorific value is 13.34 MJ/kg. Meanwhile, other parameters that support the growth of microorganisms in the biodrying process are lignin, cellulose, Nitrogen, Carbon-organic (C-organic), and Phosphate are 20.55%; 37.56%, 2.26%, 30.05%, and 0.42%, respectively.

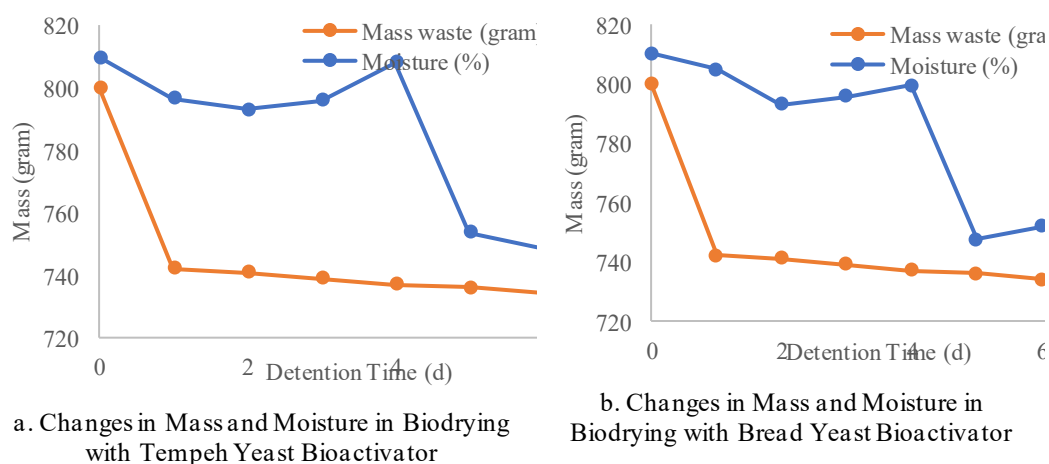
The biodrying process focuses on aerobic technology, which reduces the moisture content to steam due to high temperatures and adequate ventilation. Biodrying process showed that proper aeration settings (e.g., discharge and flow direction) and temperature are able to reduce water content

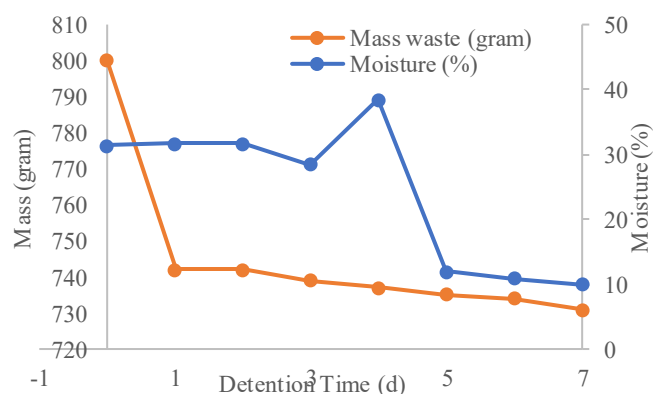
efficiently (Adani et al., 2002; Sugni et al., 2005). However, the principle of aerobic biodrying technology is to promote evaporation using the energy generated by the degradation of organic matter. The amount of organic carbon contained in the raw material of coconut leaf waste is 30.05%, and cellulose is 37.56%. The addition of aeration in the biodrying process can increase the partial disintegration and hydrolysis of macromolecular organic compounds such as C-Organic, cellulose, hemicellulose, lignin, total nitrogen (Nguyen et al., 2007). The cellulose content in coconut leaf waste causes the decomposition process of this waste to take a very long time to do.

**Table 1.** Results of Measurement of Initial Characteristics of Coconut Leaf Waste

Parameters	Waste Initial Characteristic
Moisture (%)	31.4 -36.1
Ash (%)	8.36
Caloric Value (MJ/kg)	13.34
Lignin (%)	20.55
Cellulose (%)	37.56
N (%)	2.26
C-Organic (%)	30.05
C/N Ratio	13.3
P (%)	0.42

Changes in moisture and mass can be seen in Figure 2. It can be seen that each variation of the addition of bread has almost the same trend, where the largest decrease in mass occurs on the first day. Changes in mass tend to start steady after the first day. Meanwhile, moisture began to decrease on the fifth day.

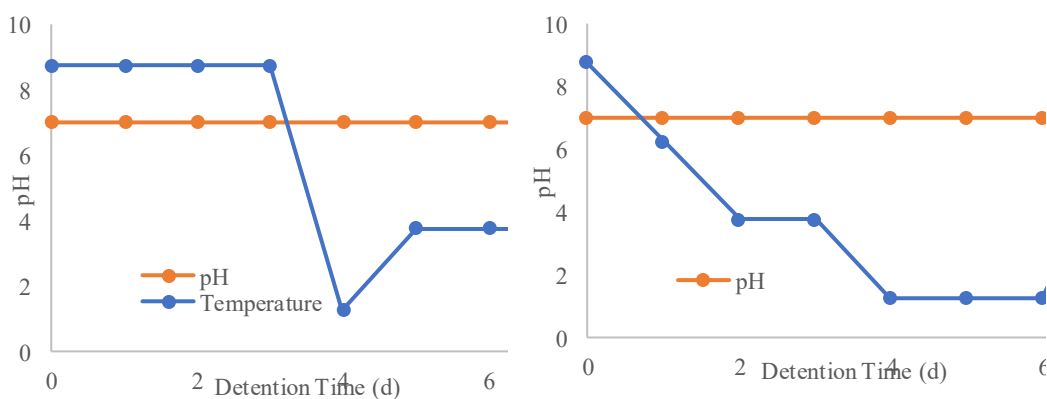




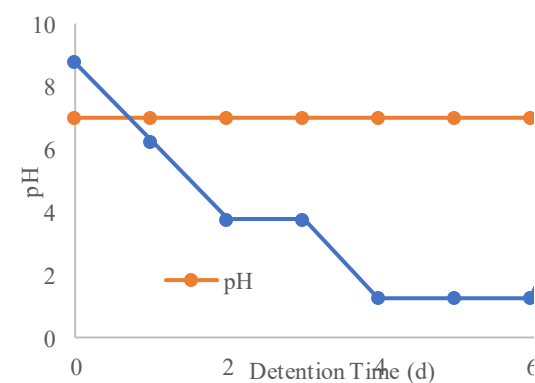
c. Changes in Mass and Moisture in Biodrying with Tapai Yeast Bioactivator

**Figure 2.** Changes in Moisture Trends and Waste Mass During the Biodrying Process with Tempeh Yeast (a) Bread Yeast (b) and Tapai Yeast (c)

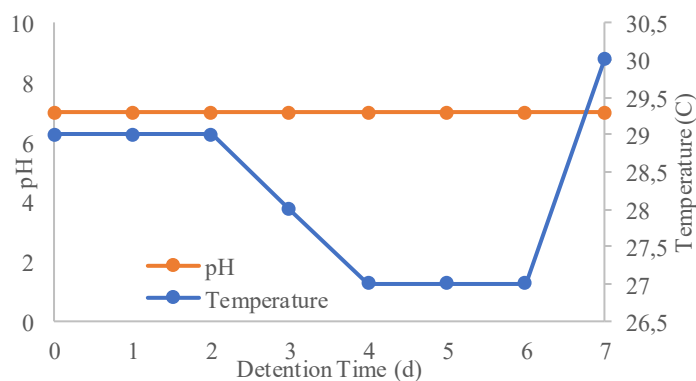
Figure 3 shows the trend of changes in pH and temperature during the biodrying process. The pH in the processing does not change during the process, which shows that the pH value is still in a normal pH condition of 7. At the same time, the temperature in each bioactivator has a different value. The trend for tempeh yeast and tapai yeast tends to be the same. The percentage of weight loss in the tempeh yeast variation was higher, while the reduction was almost the same (Figure 4).



a. Changes in pH and temperature in Biodrying with Tempeh Yeast Bioactivator



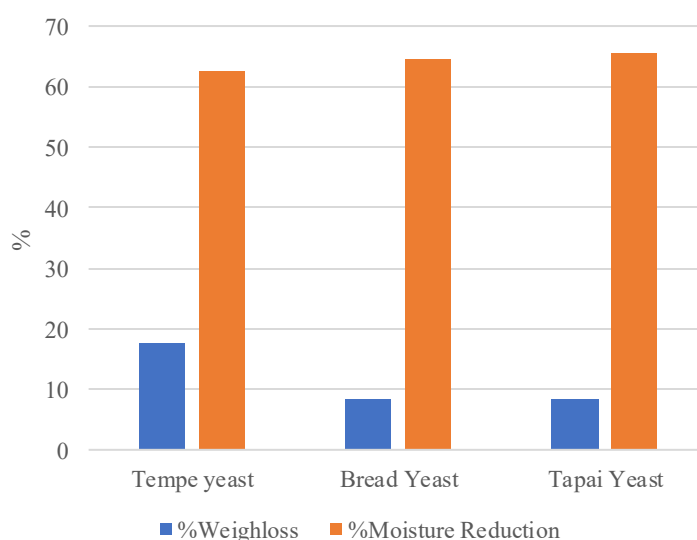
b. Changes in pH and temperature in Biodrying with Bread Yeast Bioactivator



c. Changes in pH and temperature in Biodrying with Tapai Yeast Bioactivator

**Figure 3.** Changes in the pH and Temperature Trends of Waste During the Biodrying Process with Tempe Yeast (a) Bread Yeast (b) and Tapai Yeast (c)

The temperature in the processing process tends to be high at the beginning of processing and decreases with processing time. A gradual decrease in biodrying temperature is an indication that the activity of microorganisms is going well (Debertoldi et al., 1983). The higher temperature causes the evaporation of water and extractive materials as well as the degradation of hemicellulose so that the water content decreases. Temperature affects biodrying, affecting the biodrying product as indicated by the value of water content, ODS (organic dry solid), carbon and ash (Fadlilah & Yudiyanto, 2013). pH normal during the processing indicates the occurrence of the optimum microbial process in processing coconut leaf waste. The pH value of 6.7-9.0 strongly supports microbial activity during the degradation process (Sofiyah & Suryawan, 2021).



**Figure 4.** The Effectiveness of Weight Reduction and Moisture Reduction in the Biodrying Process for 7 days

In Table 2, it can be seen that the highest calorific value was obtained with the addition of yeast bioactivator. The increase in calorific value with the addition of bioactivator can reach 25.87 to 28.36%. The processing results showed that the highest mass decrease was higher on day 2, while the decrease in moisture content tended to occur on day 5. The amount of energy also required mainly depended on the amount of water content of the waste. If the water content of the waste is high, the energy required for drying and burning is also high (Sarwono et al., 2021). The effectiveness of the biodrying process is high-temperature differentiation, namely the necessary gradual temperature increase, stirring to accelerate heat transfer, and the size of the sample.

**Table 2.** Value and Change in Waste Calorific Value for Each Biodrying Process Variation

Bioactivator	Caloric Value (MJ/kg)	% Increase of Caloric Value from Initial
Tempe Yeast	18.623	28.36
Bread Yeast	18.167	26.57
Tapai Yeast	17.995	25.87

The percentage of mass loss in this study has differences in other studies. Other studies have shown that the mass reduction in the biodrying process can be more than 30% (Colomer-Mendoza et al., 2013; Mohammed et al., 2017). This may be because the detention time given is not long enough, whereas other studies require more than 14 days. In addition, coconut leaf waste also has a fairly

high cellulose content compared to food waste, usually used in the biodrying process. However, 14 days is considered long enough, so 7 days is also good enough. In terms of quality, the measurement of the calorific value of the results of biodrying processing can reach 17.995 – 18.623 MJ/kg, which increases to 25.87 – 28.36%. Biomass pellet raw materials based on Indonesian standards must meet the minimum standard of 16.50 MJ/kg (SNI 8675:2018). This shows that the raw material for coconut leaf waste, which was previously 13.34 MJ/kg, has not met the criteria applied in Indonesia. This biodrying process will provide the possibility that coconut leaf waste can be used as raw material for biomass pellets.

## CONCLUSION

Loss of weight and moisture in coconut leaf waste during the biodrying process can reach 8.25-17.62% and 62.4-65.6%, respectively. The increase in calorific value can also reach 25.87 to 28.36%. The final calorific value in the biodrying process can reach the Indonesian minimum standard for biomass pellets, which is 17.995-18.623 MJ/kg.

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